MEDICINAL PLANTS USED BY BELIZEANS IN THE TREATMENT OF WOMEN'S AND CHILDREN'S HEALTH ISSUES

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ABSTRACT

During 2012, 30 herbal doctors in Belize, Central America, each viewed 50 plant specimens with reported medicinal value. Each participant was asked to provide a plant name and a medicinal use to identify species used to treat women's and children's health issues. Chi-square tests indicated that knowing a name and knowing a use were associated ($p \leq 0.05$). Participant gender was not independent of knowing a name or a use. The age of a participant was not independent of knowing a name but was independent of knowing a use. The district of residence was independent of knowing either name or use. Based on model selection by Akaike information criterion, gender was the best fit model for knowing a plant name. For use, gender, district, and the null model (participant only) had equal goodness of fit. Reports of use were partitioned into 23 usage categories. Six categories had high informant consensus (>0.65). From the categories with high consensus, five species had been previously reported for similar uses in relevant studies.

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INTRODUCTION

Ethnobotany, the scientific study of ethnic groups and their cultural use of plants, includes food, construction, and the focus of this study, medicine. Globally, three billion people rely on traditional medicine and use plant products for primary health care (Balick 1999). Although ethnobotanical medicines have sustained many cultures for generations and contributed much to the lives of indigenous people, it is studied less frequently by subsequent generations (Montenegro and Stephens 2006) and knowledge accumulated over thousands of years is at risk of being lost. Medicinal use of plants is not only an important part of culture (Ankli *et al*. 1999) but often traditional medicines are the only accessible or affordable healthcare option in developing countries (Balick *et al*. 1990). Half of the 250,000 flowering plants reported are located in the tropics and, of these, only 1% has been investigated for their pharmaceutical properties (Jachak and Saklani 2007, Maridass 2010). Tropical environments are being deforested at an alarming rate and there is an urgency to gather knowledge on the diversity of these habitats before they are destroyed (Amiguet *et al*. 2005, Ankli *et al*. 1999). Of particular concern is the loss of tropical species that have medicinal value (Balick 1999).

Belize

Belize is a relatively small country, approximately the size of Massachusetts with a land mass of 22,806 km^2, bordered by the Caribbean Sea, Guatemala and Mexico (CIA 2013). Belize provides an ideal site for investigating medicinal plants. The people have a strong ethnobotanical culture and tropical habitats remain. For example, Belize is 80% forested versus only 2% for El Salvador, a similar size country (Amiguet *et al.* 2005).

Economic Botany

For these reasons, Belize was chosen as the site for the investigation presented here.

Review of Literature

The first published studies on the Yucatan area, Thompson (1930) and Roys (1931), focused on ethnological knowledge and general plant use. In more recent years Pendergast (1972), Arnason *et al*. (1980) have contributed to the acquisition, validation, and dissemination of the medicinal plant knowledge of the area. Much of the recent literature about medicinal plants in Belize has focused on the Q'eqchi' Maya subgroup because they are culturally less assimilated than other groups (Amiguet *et al*. 2005). The Q'eqchi' studies used male participants. Female healers, midwives, and women's and children's health (WCH) issues have not been a strong focus in Belize although this type of study has been conducted in the neighboring countries of Mexico (Locklear *et al*. 2008) and Guatemala (Michel *et al*. 2007). Studies in Belize that did address WCH conditions, such as lead exposure in children (Charalambous *et al*. 2009), or perceptions towards human immunodeficiency virus in brothels (Ragsdale *et al*. 2007), made no mention of traditional plant use in the treatment of these or other illnesses.

Thesis Statement

The study had five primary objectives: 1) identify plants used in Belize for women and children's health and their use; 2) determine the degree of consensus for medicinal plant uses by participating practitioners; 3) identify the plant families most frequently used by the practitioners; 4) describe the variation among practitioners in knowing plant name and use based on three demographic variables (age, gender, district of residence); 5) Determine commonality of use and plant species by comparing the results of this study with those in nearby areas.

METHODS AND MATERIALS

Overview

The project began with an extensive literature investigation to determine an area in need of study leading to the question: what medicinal plants are used for Belizean women's and children's health issues and for what ailments are they useful. Information on this subject was scarce. *Ethnobotany: A Methods Manual* (Martin 2004) was helpful in understanding some important aspects of ethnobotanical studies including what types of data to collect, how they might be used and the value of including a broad range of participants.

After completion of the required National Institute of Health on-line training for research projects using human subjects, the interview protocol was developed. During this time, questionnaires for the personal interviews and for the interviews regarding the name and use of medicinal plant specimens were developed. Three Belizeans with experience in traditional medicine agreed to participant in the pilot study to test the procedures and questionnaires for the project. The pilot study resulted in the revision of several questions using terminology more appropriate to the Belizean culture. It also identified the need to interview participants in the participant's native language, usually Spanish. Participants who spoke English as a second language gave much more thorough answers when interviewed in their native language. These three people were not re-interviewed later nor were their data included in this study beyond its use in the assessment of the project protocols during the pilot study; however, all later assisted in the project. Heriberto Cocom, a medicinal herbalist teacher of plant medicine with more than 60 years of experience and training, provided assistance as a liaison to healers and as the project's plant expert. Virgilio Garcia helped with transportation to sites and collected plant voucher specimens used to validate the study.

Matilde Garcia also assisted in collecting plant specimens and conducted interviews in Spanish for Spanish speaking participants.

Approvals and Permits

The National Institutes of Health online training for research involving human subjects was completed (certificate number 1228490759) in preparation for this study. The Angelo State University (ASU) Institutional Review Board (IRB) approved the project and interview methods. Landowner consent forms for plant collection were completed and permissions obtained from participating landowners. Plant collecting permits were obtained from the government of Belize (Minister of Natural Resources, Ref # CD/60/3/12 (38), May 2012).

Study Site

This study was conducted in the Orange Walk and Cayo Districts of Belize. These two adjoining districts are on the western side of the country, both bordering Guatemala. Orange Walk shares its northern border with Mexico. Cayo, the southern of the two areas, has low mountains and the climate is categorized as tropical monsoon (Am) by the Köppen-Geiger climate classification system. The Orange Walk District is partially Am in the southern portion while the northern area is categorized as tropical wet and dry (Aw) and is characterized by low lands and savannahs (Belize Meteorological Service 2013).

Participant Questionnaires

Balick (1996) demonstrated the value of interviews in the investigation of local plant use when new uses were described after interviewing as many as 40 people. Two forms were used during interviews, a personal form and a plant species form. The personal interview form, a semi-structured questionnaire consisting of 34 questions, was used to obtain information concerning each participant's training and background. Questions used were similar to those used in interviews by Bussmann and Glenn (2010) and Hilgert and Gil (2007). In addition, a plant species form was used to record the names and uses for each plant specimen as participants viewed 50 dried and pressed specimens.

Participants were first asked to fill out and sign a "subject consent to participate in research" form. This form was approved by the ASU IRB and was provided to participants in both English and Spanish. This form included an explanation of the purpose of the study, what participants could expect to occur, and how they could stop participating in the study. Participant interviews began with a series of questions to provide a general understanding of their background and extent of medicinal knowledge. Interview questions included basic information such as name, date of birth, place of birth, age, gender, ethnicity, occupation, religion, marital status, and number of people/generations living in their home. Additionally, participants were asked their level of education, language ability (fluency, number of languages), literacy, who taught them plant medicines, number of years of training, why they learned, who they treat, whether or not they charge for services, work with a partner, and have or were presently teaching this knowledge to another and, if so, are they related to the person being taught. Lastly, they were asked if they maintain a written record of their knowledge, how many medicinal species they know, how many recipes for medicine they know, and how many species they cultivate for their own use.

Interviews were conducted in either English or Spanish as requested by the participant. A video recording, using a Sony HDR-XR520v Handycam, was used to capture aspects of the interviews that do not translate easily to a written form such as a participant's demeanor, and information said in passing. The video data also allowed later review of interviews to verify details when necessary to ensure an accurate dataset. Participants wore a wireless microphone to ensure no dialogue was lost.

Participants

The 30 participants varied by location of residence, gender, and age. One half (50%) of the participants were from the Orange Walk District; the remaining participants were from the Cayo District. Males accounted for 40% of the participants; 60% were females. Participant ages ranged from 18 to 81 with a mean age of 62. When using Jenks natural breaks, participant ages were distributed bimodally with a single outlier on the low end. This grouping did not represent the participants well and was not informative. Dividing the participants into too many groups would reduce sample size and statistical power of tests. Therefore, participants were divided into four groups by age and, in general, the groups represented typical stages of progression through life. For example, groups represented youths without children, developing family, developed family, and elders. Group 1 consisted of one participant who was less than 25 years of age. Group 2 was formed of participants whose ages ranged from 25 to 49 and represented 23% of the study group. Group 3 had participants from ages 50 to 74 (53%). Group 4 represented 20% of the participants who were age 75 and older. These groups were best suited to the data and best represented the different life stages of the participants.

Selection of Plants Used for Women’s and Children’s Health Issues

During the personal interview, participants were asked to discuss plants of medicinal value used for women’s and children’s health issues. Eight of the 30 participants contributed a total of 25 species. Heriberto Cocom, the project’s medicinal plant expert, provided an additional 25 specimens. These 50 plant specimens comprised the plant set for the plant species interviews. Three species from the 25 selected by the participants, were duplicated in the set contributed by the study's plant expert. This was done as a reliability check for participant responses. Responses given for the three duplicate specimens were not included in any of the statistical analyses.

After personal interviews were completed for all participants, a second interview was conducted for each participant using the 50 medicinal plant specimens in the study set. Each participant viewed the complete set of plants one specimen at a time and was given unlimited time to view, smell, and touch the specimen. Often crushing a leaf releases odors in newly dried materials so destructive sampling was allowed. All 30 participants completed the set of 50 specimens. Plant species interviews resulted in a completed data form detailing which study plants were known by the participant, the local name of the plant, ailments it was used for, and a video recording of the interview.

Plant Vouchers and Collections

Each plant species in this study was photographed in its habitat, using a Sony DSC-H20 10.0 megapixel camera, to preserve details like color, growth form, and habitat. Global Positioning System coordinates were recorded for each plant collection area using a Garmin unit model M60 (WGS84) with an accuracy of <15m. Four complete sets of voucher specimens were collected, dried, fumigated and received phytosanitary certification from the government of Belize. Specimen identifications were accomplished using taxonomic family keys at the University of Texas at Austin's (UTA) Plant Resource Center, comparisons with herbaria specimens at the UTA Plant Resource Center, and assistance from botanists Drs. Tom Wendt, curator of UTA Plant Resource Center and Billie Turner, Director Emeritus of the Plant Resource Center.

The data collected in this study are stored in duplicate sets. One is stored by the principle investigator, and a second is stored in the Angelo State Natural History Collections Herbarium in the Biology Department of ASU. The two sets of records are identical except for the original hand written field notes that are retained by the principle investigator. A scanned digital copy of these notes are included as part of the second dataset. Reports of this study and other end products have been provided to and are archived by the government of Belize.

Four sets of voucher specimens of the 50 medicinal plants used during the plants species interviews were collected. A set was donated to The National Herbarium in Belmopan, Belize, the Angelo State Natural History Collections Herbarium, and the University of Texas at Austin Plant Resource Center. The principle investigator kept the fourth set. During the study, no trails were cleared and impact to the land was limited to collection of selected specimens as approved by the Forestry Department of Belize. No marking, chemical use or transplanting was done. In many cases only a portion of the plant was harvested to mitigate long-term harm to the plant.

Specimens were collected in August, 2012. Plants were pressed using newspapers and aluminum ventilators inside standard plant presses coated in polyurethane. A simple drying cabinet approximately 20” x 20” x 44” was constructed from 2” x 2” boards screwed together to form a frame large enough to support several presses at one time. Presses were placed on top of the frame on their sides. The frame base and the exposed sides of the presses were wrapped in several layers of tightly woven cotton fabric that forced air to rise through the presses as it escaped the chamber. A Patton heater, model PUH682, was used as a heat source. The heater was set on the lower wattage setting (750w) and the thermostat was set at approximately 25%. This resulted in heating cycles of 18-22 seconds separated by periods from 137-145 seconds in which the dryer was off. The air inside the chamber maintained an approximate temperature of 60° C (140° F). A specimen typically dried in 48-96 hours depending on the thickness of the specimen, the moisture in and on the plant at the time of collection, and environmental conditions during drying such as humidity and precipitation. Although specimens were collected during the rainy season, this technique dried specimens successfully without fungal or bacterial contamination.

Terminology

Much of the methodology and terminology for this study was based on Amiguet *et al*. 2005 study. For example, a single record of use by a participant for one of the 50 plants is termed a “use-report.” The term “usage category” is used to group aliments into related systems. A participant may have many use-reports for a species but it may only be counted once for each usage category. Participants’ interviews were independent and data were compiled to form a single dataset. Twenty-two usage categories, all recognized by the Economic Botany Data Collection Standard (Cook, 1995), were used. The category “culture-bound syndromes” (Weller *et al*. 2002) was included to classify folk illnesses that are not recognized as diseases by medical practitioners. There were twenty-three usage categories used: blood system disorders (BLO), circulatory system disorders (CIR), culture-bound syndromes (CUL), digestive system disorders (DIG), endocrine system disorders (END), genitourinary system disorders (GEN), Ill-defined syndromes (IDS), for example, dizziness, fainting, malaise/fatigue, and growing pains, immune system disorders (IMM), infections/infestations (INFE), inflammation (INFL), injuries (INJ), mental disorders (MEN), metabolic system disorders (MET), muscular-skeletal system disorders (MUS), neoplasms

(NEO), nervous system disorders (NER), nutritional disorders (NUT), pain (PAI), poisonings (POI), pregnancy/birth/puerpuerium disorders (PRE), respiratory system disorders (RES), sensory system disorders (SEN), and skin/subcutaneous cellular tissue disorders (SKI).

Data Analyses

The dataset generated from participant interviews was analyzed using Pearson's Chi-square tests to identify the parameters significantly associated with knowing a name and/or a use for the 47 medicinal plant specimens. Participant responses for specimen duplicates are not included in the analyses. The same test was used to compare both name and use to three demographic variables, which were 1) gender, 2) age, and 3) participant's location of residence. Mixed-effects logistic regression examined the effect of demographic variables on the probability of knowing a name or use for the plants. Mixed-effects models were used to account for the pseudoreplication by treating the individual as a random effect. Akaike information criterion (AIC) was used to select a statistical model, based on different combinations of three variables, to identify which variables best described the variation in the data. The reports of use were then partitioned into twenty-three usage categories and a binomial test was conducted to investigate association between the participant knowing a use for the medicinal plant specimen and also knowing a name for the specimen in each usage category. Each category was then also independently analyzed for informant consensus.

Consensus

Consensus methods have been used successfully in several ethnobotanical studies to verify results and to identify, through universal uses by multiple users, plants with potentially important active compounds (Amiguet *et al.* 2005, Trotter and Logan 1986, Heinrick, 2000 Johns *et al*. 1990, Phillips and Gentry 1993, Johns *et al.* 1994). Consensus analyses were used in this study to determine the commonality of the uses of the 47 study plants among the 30 study participants. The number of use reports (n_{ur}) compared to the number of species in each category of use (n_{raxa}) was used to calculate the informants' consensus factor (F_{ic}) which is the degree of agreement among participants using the following formula as given in Amiguet *et al.* (2005). This can easily be converted to a percentage for participant agreement.

$$F_{ic} = \frac{n_{ur} - n_{taxa}}{n_{ur} - 1}$$

RESULTS

Name and Use

Fifty specimens, including three duplicates, were studied one at a time by each of the 30 participants (N=1500). All participants provided the same response for each of the three duplicates suggesting a reliability of responses. A total of 47 plants (N=1410), with no duplicates, was used in the analyses. There were four possible results (Table 1) for participant responses: 1) participant knows name and knows use (33.5%), 2) participant knows name but does not know use (5.9%), 3) participant does not know name but does know use (10.5%), and 4) participant does not know name or use (49.9%). The most frequent response was participants not knowing either a name or a use. The least frequent observation was participants knowing a name for the plant but not a use.

Males knew a name for specimens more frequently than females (Table 1). Males also knew a use for the specimens more frequently than females. The difference in positive responses from participants from Cayo District and Orange Walk District was less than 1% for name and 2% for use. With the exception of a single outlier participant in the less than 25 years of age group; there was no more than a 9% difference in the number of observed reports for name and a 9% difference for observations for use by the other three age groups.

Table 1. Number of participants, percentage of study group, and percentages of positive responses for knowing name and for knowing use by gender, age groups, and district.

Groups	N value	Percent	Name	Use
Male	11	37%	46%	48%
Female	19	63%	36%	42%
Age <25	1	3%	55%	53%
Age 25-49	7	23%	34%	47%
Age 50-74	16	53%	43%	44%
Age 75+	6	20%	34%	38%
Cayo District	15	50%	39%	43%
Orange Walk District	15	50%	40%	45%

A Pearson's Chi-square test was used to address the association of a participant knowing a plant name with knowing a use (X^2 = 621.9, df = 1, $p \leq 0.001$). Results of the test showed that name and use were not independent of each other. If a participant knew the plant name he/she could be expected to know a use. Males knew a name for the plant specimens 46% of the time and knew a use 48% of the time. Females knew a name for the plant specimens 36% of the time and knew a use 42% of the time. Pearson's Chi-square tests showed that gender was not independent of name (X^2 = 12.896, df = 1, $p \leq 0.001$) or use (X^2 = 4.922, df = 1, $p \leq 0.05$)

Pearson's Chi-square tests also indicated that the age of the participant was not independent of knowing a name (X^2 = 17.052, df = 3, $p \leq 0.001$). However, age was independent of knowing a use (X^2 = 6.668, df = 3, p = 0.083). Pearson's Chi-square tests was used to determine if the location of a participant's residence was a factor in knowing a name and use. District of residence was independent of knowing both a name (X^2 = 0.074, df = 1, p =0.785) and for knowing a use (X^2 = 0.564, df = 1, p =0.453).

Model Selection

Akaike information criterion (AIC) was used to select a statistical model, based on different combinations of variables, to identify which variables best describe the variation in the data (Burnham and Anderson 2002). Models tested included combinations of gender, age, and district for each individual participant. Results showed that the model with only gender was the best model for knowing the name of a plant. For plant use, no model displayed a better fit than the null model. Models with only gender or only district and the null model (participant only) had similar AIC values indicating equal goodness of fit (Table 2).

Table 2. AIC value for name and use in model selection.

Model	AIC (Name)	AIC (Use)
Age + Gender * District + (1/Participant)	1865.5	1915.3
Gender + Age + District + (1/Participant)	1863.8	1917.1
Gender + Age + (1/Participant)	1861.9	1915.1
Gender + District + (1/Participant)	1861.7	1913.4
Age + District + (1/Participant)	1864.2	1916.8
Gender + (1/Participant)	1859.7*	1911.5**
Age + (1/Participant)	1862.4	1914.9
District + (1/Participant)	1863.9	1913.0**
1 + (1/Participant) (Null Model)	1862.0	1911.2**

*Best fit of model; **Models with equal goodness of fit.

Use reports placement into categories

Each participant was asked to report as many uses he/she knew for each plant species. Plant uses reported by participants were grouped by body systems. The body system groups used were those from the Economic Botany Data Collection Standard (Cook 1995). Using this system required some interpretation by the interviewer. Reports of multiples uses from a participant could result in a single recorded entry. For example, a participant might report a plant could be used for pain in the foot, in the leg, and in the shoulder. Although the pain is in three different locations in the body, all three uses are in the pain category and the three uses would be recorded as a single use-report. However, when a plant species was reported to be helpful for pain caused by injury, infection, or poisoning, each ailment was considered independent because each affected different body systems and three use-reports were recorded. This methodology follows procedures used in Amiguet *et al.* (2005).

A total of 771 unique use-reports were reported for the 47 plant specimens, which collectively represented 23 usage categories. Seventy-six (9.8%) reports did not fit in any of the recognized usage categories as they were folk illnesses not recognized as diseases by biomedical practitioners. These were grouped in a category called “culture-bound syndromes” following Weller *et al.* (2002). For example, this category includes *susto*, a condition resulting from emotional trauma usually afflicting children.

Categories Totals

The most frequent plant use reported was for infection, with 176 records. The remaining categories ranged from 95 reports for skin/subcutaneous cellular tissue disorders (Table 3) to a low of two reports each in the ill-defined syndromes and the metabolic disorders categories.

Table 3. Percentages of total use reports, frequency, and observations in which name was known for each usage categories by descending counts of use-reports. P-values show the probability of knowing the plant name for the usage category identified.

Usage Categories	Percentage of Use-reports	Counts of Use-reports	Counts for Knows Name	Value
Infections/infestations (INFE)	12.5	176	141	≤0.0001
Skin/subcutaneous cellular tissue Disorders (SKI)	6.7	95	78	≤0.0001
Cultural bound syndromes (CUL)	5.4	76	56	≤0.0001
Pain (PAI)	4.7	66	47	≤0.001
Genitourinary system disorders (GEN)	4.5	64	47	≤0.001
Digestive system disorders(DIG)	3.8	53	45	≤0.0001
Blood system disorders (BLO)	2.6	37	34	≤0.001
Inflammation (INFL)	2.6	37	28	≤0.05
Endocrine system disorders (END)	2.3	32	25	≤0.05
Pregnancy/birth/puerpuerium disorders (PRE)	1.8	25	16	*ns
Nervous system disorders (NER)	1.1	15	14	≤0.001
Injuries (INJ)	1.0	14	8	ns
Neoplasms (NEO)	1.0	14	12	≤0.05
Circulatory system disorders (CIR)	0.9	13	9	ns
Respiratory system disorders (RES)	0.9	12	10	≤0.05
Mental disorders (MEN)	0.7	10	10	≤0.05
Muscular-skeletal system disorders (MUS)	0.6	8	6	ns
Poisoning (POI)	0.4	6	4	ns
Immune system disorders (IMM)	0.4	5	4	**nt
Nutritional disorders (NUT)	0.4	5	5	nt
Sensory system disorders (SEN)	0.3	4	3	nt
Ill-defined syndromes (IDS)	0.1	2	1	nt
Metabolic system disorders (MET)	0.1	2	2	nt

*ns = not significant; **nt = not testable

A binomial test indicated an association between the participant knowing a name for the plant species and also knowing a use for the species in the following categories: blood system disorders, culture-bound syndrome, digestive system disorders, endocrine system disorders, genitourinary system disorders, infections, inflammations, mental disorders, neoplasms, nervous system disorders, pain, respiratory system disorders, and for skin/subcutaneous cellular tissue disorders (Table 3). Pregnancy/birth/puerpuerium, injuries, and circulatory system disorders categories did not exhibit an association between knowing a use and knowing a name.

Sample size for muscular-skeletal disorders and poisoning categories were testable but require 100% positive responses to obtain a p-value $\leq$0.05. Neither category met this condition. Additionally, due to small sample sizes, below the cutoff point for significance testing, probability values for ill-defined syndromes, immune system disorders, nutritional disorders, metabolic system disorders, and sensory system disorders could not be calculated.

Informant Consensus Factor

Heinrich (2000) and Amiguet *et al*. (2005) used participant consensus factor values as a means of indicating which species are well known among healers. A high level of consensus suggests that these plants are part of a well-defined tradition and that they may be very effective in the treatment of disease (Amiguet *et al*. 2005). In the aforementioned studies, the authors suggested that species with a high consensus factor should be further investigated for pharmacological usefulness. Heinrich (2000) defined a consensus factor as high if the value was 0.60 or higher; Amiguet *et al*. (2005) used 0.65 or higher as a high value. The informant consensus factor (F_{ic}) was calculated for each of the 23 usage categories resulting in six with values $\geq$0.65 (Table 4). These categories, in alphabetical order, are blood system disorders, culture-bound syndromes, infections, mental disorders, nervous system disorders, and skin/subcutaneous cellular tissue disorders. The number of taxa that the participants used to treat ailments in each of the 23 usage categories ranged from 40 in the INFE category to a low of two in both IDS and MET (Table 4) categories.

Table 4. Usage categories, number of use reports, number of taxa, and informant consensus factor (F_{ic}) value for each of the 23 usage categories by descending F_{ic} value. Categories with a F_{ic} value ≥0.65 are considered a high level of consensus.

Usage Category	No. of Use-reports	No. of Taxa	$\boldsymbol{F_{ic}}$
NER	15	4	0.79
INFE	176	40	0.78
MEN	10	3	0.78
BLO	37	11	0.72
SKI	95	31	0.68
CUL	76	27	0.65
PAI	66	28	0.58
DIG	53	23	0.58
END	32	14	0.58
GEN	64	28	0.57
NEO	14	7	0.54
INFL	37	18	0.53
CIR	13	7	0.50
INJ	14	9	0.38
MUS	8	6	0.29
RES	12	9	0.27
PRE	25	19	0.25
NUT	5	4	0.25
POI	6	5	0.20
IMM	5	5	0.00
SEN	4	4	0.00
MET	2	2	0.00
IDS	2	2	0.00

Specimen Identification

The 50 medicinal plant specimens were identified by the use of dichotomous keys, comparison to accessioned herbarium specimens at the University of Texas at Austin's Plant Resource Center, and the aid of experts in the plant families at the Plant Resource Center. Of the 50 medicinal plant specimens shown to each of the study's participants 47 were identified to the family level (Table 5). There were a total of 44 unique species identified. Three were intentional duplicates used as a participant response reliability check. The *Catalogue of Life: 2014 Annual Checklist* (Roskov *et al.* 2014) was used as the taxonomic source for all names except *Parmentiera millspaughiana* for which The Global Biodiversity Information Facility was used. A lack of reproductive material hindered identification of three species to family and several other species identification could not be made below the family level. The 44 identified species were distributed among 31 plant families. Seven of the 31 plant families included more than one species. These families listed by order of most frequent to least are Fabaceae (4), Solanaceae (4), Euphorbiaceae (3), Rutaceae (3), Asteraceae (2), Malvaceae (2), and Rubiaceae (2). The other 24 plant families are represented by one species in the study set.

Table 5. List of plants in the study set and identifications, when possible.

Family	Genus
Menispermaceae	*Cissampelos tropaeolifolia* DC.
Specimen #2: NA	NA
Euphorbiaceae	*Cnidoscolus aconitifolius* (Mill.) I.M. Johnst.
Cactaceae	*Nopalea cochenillifera* (L.) Salm-Dyck
Burseraceae	*Bursera simaruba* (L.) Sarg.
Rutaceae	*Ruta chalepensis* L.
Fabaceae	*Bauhinia herrerae* (Britton & Rose) Standl. & Steyerm.
Polypodiaceae	*Phlebodium decumanum* (Willd.) J. Sm.
Bignoniaceae	*Parmentiera millspaughiana* L. O. Williams
Euphorbiaceae	*Ricinus communis* L.
Solanaceae	*Capsicum annuum* L.
Malvaceae	*Sida glabra* Miller
Rubiaceae	*Hamelia patens* Jacq.
Fabaceae	*Cassia grandis* L. f.
Urticaceae	*Cecropia peltata* L.
Solanaceae	*Solanum lycopersicum* L.
Xanthorrhoeaceae	*Aloe vera* (L.) Burm. f.
Fabaceae	*Mimosa pudica* L.
Phyllanthaceae	*Phyllanthus liebmannianus* Müll. Arg.
Solanaceae	***Solanum torvum* Sw.
Meliaceae	*Cedrela odorata* L.
Lauraceae	*Persea americana* Mill.
Annonaceae	*Mosannona depressa* (Baill.) Chatrou
Lamiaceae	*Mentha* sp.
Verbenaceae	***Stachytarpheta cayennensis* (Rich.) Vahl
Acanthaceae	*Blechum pyramidatum* (Lam.) Urb.
Amaranthaceae	*Alternanthera* sp.
Asteraceae	**Sphagneticola trilobata* (L.) Pruski
Euphorbiaceae	*Euphorbia pulcherrima* Willd. Ex Klotzsch
Fabaceae	*Piscidia piscipula* (L.) Sarg.
Lygodiaceae	*Lygodium venustum* Sw.
Oxalidaceae	*Oxalis alpina* Rose ex Knuth
Rutaceae	*Zanthoxylum* sp.
Asteraceae	**Parthenium hysterophorus* L.
Specimen #37: NA	NA
Rutaceae	*Murraya paniculata* (L.) Jacq.
Malvaceae	*Byttneria aculeata* Jacq.
Solanaceae	Specimen #40: NA
Apocynaceae	***Tabernaemontana donnell-smithii* J. N. Rose ex J. D. Smith
Araceae	Specimen #42: NA
Nyctaginaceae	*Bougainvillea glabra* Choisy
Specimen #44: NA	NA
Sapindaceae	*Serjania lundellii* T. B. Croat
Rubiaceae	*Psychotria berteroana* DC.
Moraceae	*Brosimum* sp.
Myrtaceae	*Eugenia capuli* (Schltdl. & Cham.) Hook. & Arn.
Piperaceae	*Piper* sp.

*Provisionally accepted names; ** Duplicated specimens

DISCUSSION

The use-reports can be used to help identify plant species with higher relative medicinal importance. A high consensus factor indicates a well-defined tradition of medicinal plant use and could aid in guided selection of plant species for future phytochemical, bioactivity, and toxicological investigation. Twenty-six of the 31 plant families and ten species of plants identified in this study have been reported in prior studies as having medicinal use.

Comparison of Study Plants with Previous Studies

Although not focused on WCH issues, several other studies were identified that either addressed similar questions or were conducted in nearby geographical areas, and included identification of plant names and uses. These studies include Amiguet *et al.* (2005), Ankli *et al.* (1999), Bussman and Glenn (2010), Michel *et al.* (2007), Jenett-Siems *et al.* (1999), and Yasir *et al.* (2010). Plants identified in these studies were compared to the species identified here as important to WCH issues. Of the 31 plant families included in this study five were not reported in the previously listed studies. These five plant families are: Lygodiaceae, Phyllanthaceae, Sapindaceae, Apocynaceae, and Xanthorrhoeaceae. The remaining 26 plant families in this study were reported in at least one of the previous studies stated above.

Three plant specimens that were identified only to genus were common to at least one of the previous studies. The three genera in common are *Mentha* (Lamiaceae), *Brosimum* (Moraceae), and *Zanthoxylum* (Rutaceae); all three were reported by Bussman and Glenn (2010). Their reported uses are as an aphrodisiac, as a contraceptive and for hemorrhage, and for abortion and an aphrodisiac respectively. Medicinal values, although not specified, have been reported for members of the genus *Zanthoxylum* in both Amiguet *et al.* (2005) and

Ankli *et al.* (2007). *Zanthoxylum* was cited by Calderón *et al*. (2006) as having cytotoxic properties and by Smith *et al.* (2000) for possessing antiplasmodial activity.

Ten plant specimens, which were identified to species, have been reported in one or more of the studies listed. Citations and reported uses are discussed below.

Annonaceae

Mosannona depressa has been reported by Ankli *et al.* (2007) to be used for urological disorders. This use was not reported by participants. *Mosannona depressa* was only reported as having medicinal use in the digestive system disorders, pain, and skin/subcutaneous cellular tissue disorders categories. None of these uses were reported in any of the other studies.

Burseraceae

Bursera simaruba has been reported to be effective for both pain and infection by Amiguet *et al.* (2005) and Ankli *et al.* (2007); participants in this study reported the same uses. The infections category had a high degree of consensus (78%) among participants. In this study, *Bursera simaruba* was observed to be used for culture-bound syndromes, respiratory disorders, and for skin/subcutaneous cellular tissue disorders but these uses were not reported in the other studies.

Fabaceae

Bauhinia herrerae was reported useful for treatment of gastrointestinal disorders by Ankli *et al.* (2007). No use-reports for this species fell into the digestive system disorders category. This species was reported to be effective for culture-bound syndromes, endocrine system disorders, genitourinary system disorders, infections, and pain categories.

Mimosa pudica was reported as being useful to treat insomnia by Michel *et al.* (2007). In the current study, usage reports for this species included mental disorders, which was a category with a 78% agreement among participants. According to the Economic Botany Data Collection Standard (Cook 1995), insomnia is classified within mental disorders. Other use-reports for this species included blood system disorders, culture-bound syndromes, genitourinary system disorders, infections, neoplasms, nervous system disorders, pain, respiratory system disorders, and skin/subcutaneous cellular tissue disorders categories.

Piscidia piscipula was reported by Ankli *et al.* (2007) as being used for gastrointestinal and respiratory system disorders. There were no use-reports for this species in the digestive system disorders category, but participants reported uses for respiratory system disorders. In addition, this species was reported as useful for treating culture-bound syndromes, genitourinary system disorders, infections, pain, pregnancy/birth/puerpuerium disorders, and skin/subcutaneous cellular tissue disorders. Five use-reports for this species reported use for infections. The other categories had one use-report each.

Lauraceae

Persea americana was reported by Bussman and Glenn (2010) as a contraceptive. This study did not observe pregnancy/puerpuerium disorder use-reports for *Persea americana*. Yasir *et al.* (2010) reported *P. americana* useful as an anticonvulsant, an antiviral, to heal wounds and ulcers, an antioxidant, a hypoglycemic, and for weight loss. Participants reported similar uses for the muscular-skeletal system disorders, infections, digestive system disorders, and mental disorders categories. Both infections and mental disorders categories had a high consensus value among participants. Use-reports were also observed in the genitourinary system disorders, inflammation, metabolic system disorders, pain, and respiratory system disorders categories.

Menispermaceae

Cissampelos tropaeolifolia has been reported to be used to release the placenta by both Amiguet *et al.* (2005) and by Michel *et al.* (2007). One participant (<6%) reported a single use in the pregnancy/puerpuerium disorders category. This species was also reported for culture-bound syndromes, digestive system disorders, endocrine system disorders, genitourinary system disorders, infections, inflammation, and sensory system disorders.

Rubiaceae

Hamelia patens has been reported by Ankli *et al.* (2007) as being useful for dermatological conditions and by Janett-Siems *et al.* (1999) as an antiplasmodial. Participants reported usages for *H. patens* in the treatment of disorders in skin/subcutaneous cellular tissues, circulatory system, digestive system, endocrine system, genitourinary system, infections, inflammation, injuries, muscular-skeletal system, and pain categories. The skin/subcutaneous cellular tissue disorders category also showed a high degree of consensus with 68% of participants in agreement.

Rutaceae

Murraya paniculata was reported by Ankli *et al.* (2007) to be used for respiratory system disorders. One participant reported a single use in the respiratory system disorders usage category. Other uses reported were the culture-bound syndromes, infections, nervous system disorders, pain, and skin/subcutaneous cellular tissue disorders categories.

Ruta chalepensis was reported by Ankli *et al.* (2007) to be used to treat pain and infections. Usage categories reported by participants for this species included pain, infections, digestive system disorders, inflammations, nutritional disorders, and sensory system disorders. The infection category had a high consensus among participants.

Five species, *Bursera simaruba*, *Mimosa pudica*, *Persea americana*, *Hamelia patens*, and *Ruta chalepensis*, were reported by participants to be useful for categories with a high degree of informant consensus (≥65%) and had previously been reported to have similar uses by relevant studies. *Cnidoscolus aconitifolius* was not mentioned in the other studies; however, 70% of the participants reported using this species to treat conditions in the blood disorders category.

CONCLUSION

Based on the findings of this study, a participant who knew the name of a species typically also knew the use of the species. However, in half of the observations participants did not know the name or use for a species. These results indicate that knowledge about the plants included in the plant set is limited. Only rarely did a participant know only a name or only a use. The age of a participant was associated with knowing a name for a species but not for a use. The district of residence for a participant was not important in knowing either a name or a use. The gender of the participant was important in knowing both a name and a use. In addition, gender of the participant provided the best model for knowing a name. Models with only gender or district were equal to the null model for use.

Commonality helps validate traditional uses. For example, in this study six usage categories (INFE, NER, SKI, BLO, CUL, MEN) out of 23 had high consensus values. Of these, three high consensus categories (INFE, NER, & SKI) contained four species that had been reported to have similar uses in other studies. Heinrich (2000) and Amiguet *et al*. (2005) used participant consensus factor values as a means of indicating which species are well known among healers, which suggests that these plants are may be very effective in the treatment of disease (Amiguet *et al*. 2005). In the aforementioned studies, the authors suggested that species with a high consensus factor should be further investigated for pharmacological usefulness. In addition, novelty of use can help identify alternative species and uses. For example, *Cnidoscolus aconitifolius* was used by 70% of the participants to treat blood system disorders and was not reported in any of the other studies.

In addition to the questions addressed in this paper, the dataset can be used to ask many more questions. For example: is there a difference in plant recognition depending on whether the species was contributed by participants or by the project plant expert? Would participants who share demographic attributes with the study's plant expert (male, 75 years or older, and Cayo District resident) have greater recognition of the plant species? The personal interviews provided many more demographic variables that may be investigated, for example: how does level of education, number of years practicing traditional medicine, or number of generations living in a home influence the recognition and knowledge of use? Ethnicity, occupation, and religion may be important variables. Finally, inclusion of more participants in the <25 age category would provide a better insight into that cohort.

Belize has four additional districts (Corozal District, Belize District, Toledo District, and the Stann Creek District) that were not included in this study. Will the findings of this study persist throughout the rest of the country? What are the active chemical compounds present in the plants identified here and how are these compounds related to those presently used by western medicine?

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MEDICINAL PLANTS USED BY BELIZEANS IN THE TREATMENT OF WOMEN'S AND CHILDREN'S HEALTH ISSUES

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